

Water Resources Research Center Annual Technical Report FY 2003

Introduction

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WATER PROBLEMS AND ISSUES OF MISSOURI

The water problems and issues in the State of Missouri can be separated into three general areas: 1) water quality, 2) water quantity, and 3) water policy. Each of Missouri's specific problems usually requires knowledge in these three areas.

Water Quality: News media attention to the occurrence of pesticides in drinking water in the Midwest has raised a serious public concern over the quality of Missouri drinking water and how it can be protected. With the large agricultural activity in the state, non-point source pollution is of major interest. Because of several hazardous waste super-fund sites, hazardous waste is still of a concern to the public. The Center's research has been to evaluate the quality of current waste sources and improve the methods to protect them. Areas of research for the past ten years have included (but are not limited to): erosion, non-point pollution, reclamation of strip mine areas, hazardous waste disposal, acid precipitation, anthropogenic effects on aquatic ecosystems and wetlands.

Water Quantity: Missouri has a history of either inadequate amounts of rainfall, or spring floods. Because of the 1987-1989 drought years, and the flood of 93 and 95, water quantity has become a major topic of concern. Research is needed to better understand droughts and flood conditions. **Water Policy:** Policies and programs need to be formulated that will ensure continued availability of water, as new demands are placed on Missouri water. The social and economic costs may no longer be held at acceptable levels if water becomes a major issue in cities and rural areas. Past droughts and the possible lowering of the Missouri River have raised serious questions over states' rights to water and priority uses. Research areas in this program have included drought planning, legal aspects, perception and values, economic analysis, recreation, land/water use policy and legislation, and long-term effects of policy decision.

SUMMARY OF ADVISORY COMMITTEE ACTIVITIES

The following individuals have participated in the selection and development of our 2003 research program. Because of the delay in the passing of the federal budget, the evaluation process was modified and the members sent their reviews to the Director and no formal meeting was held. The Director compiled the scoring and selected the top two preproposals for funding. Nine preproposals were submitted for consideration.

UNIVERSITY OF MISSOURI FACULTY ADVISORY COMMITTEE

1. Craig Adams University of Missouri-Columbia I-29 Agriculture Building Columbia, MO
2. Mike Chippendale University of Missouri - Columbia 1-29 Agriculture Building Columbia, MO 65211
3. Dr. John Gardner Associate Dean of Research & Outreach College of Agriculture, Food & Natural Resources 2-44 Ag Building Columbia, MO
4. Dr. Patrick Osbourne University of Missouri - St. Louis 224 Research Building St. Louis, MO 63121
5. Dr. Jerry Richardson University of Missouri-Kansas City 00126 RHFH 574 Kansas City, MO

STATE OF MISSOURI ADVISORY COMMITTEE MEMBERS

1. Dr. John Madras Department of Natural Resources Water and Pollution Control PO Box 176 Jefferson City, MO 65102
2. Dr. Steve Mellis Agricultural Engineering Extension 227 Agricultural Engineering University of Missouri-Columbia Columbia, MO 65201
3. Dr. Russell Rhodes Southwest Missouri State University 901 South National Springfield, MO 65802
4. U.S. Geological Survey 1400 Independence Road Rolla, MO 65401 Steve McIntosh Water Resources Program Department of Natural Resources PO Box 176 Jefferson City, MO
5. Hamed Mubarak 205 Jefferson Street Jefferson City, MO 65101
6. Jim Czarneszki Fisheries & Wildlife Department of Conservation 1110 South College Ave. Columbia, MO 65201
7. Becky Shannon MO Department of Natural Resources PO Box 176 Jefferson City, MO 65102

Research Program

PROGRAM GOALS AND PRIORITIES

The Missouri Water Resources Research Centers goals are: 1) establish active research programs to aid in understanding and solving Missouri's and the nation's water problems; 2) provide educational opportunities in research for students with an interest in water resources and related fields; and 3) be actively dedicated to the dissemination of water related information, using all aspects of the media.

With these goals, the Center is able to mobilize the best faculty expertise in the state to examine specific water resources problems. The Center is familiar with research needs and activities, and its goals are to help researchers avoid duplicate efforts and to serve as a link between the research community and potential users of research results - such as industries, planning commissions, and state agencies.

Because of Missouri's economy revolves around its water resources, the director and principal investigators have worked closely with the state in addressing their problems by providing research data which are necessary in order to solve present and future water problems. Each of the research projects forwarded for regional competition has undergone a thorough evaluation process by the Water Centers Advisory Committee to determine its importance in solving Missouri's and the nation's water problems.

Fate and Transport of Metal Contaminants in the Big and Black River Systems of Missouri

Basic Information

Title:	Fate and Transport of Metal Contaminants in the Big and Black River Systems of Missouri
Project Number:	2002MO1B
Start Date:	3/1/2003
End Date:	2/29/2004
Funding Source:	104B
Congressional District:	Missouri 9th
Research Category:	Ground-water Flow and Transport
Focus Category:	Surface Water, Toxic Substances, Models
Descriptors:	
Principal Investigators:	David Wronkiewicz, Craig Adams, Cesar Mendoza

Publication

Fate and Transport of Metal Contaminants in the Big and Black River Systems of Missouri

Because of delays in the funding, both at the Federal and campus levels, the investigators were unable to begin their projects last summer and have been granted a one- year time extension.

Objectives: The working hypotheses of this proposed research is that the transport and bioavailability of heavy metals in streams impacted by mining activity are a function of particle size distribution, mineralogy, density, acid leachability, specific surface area, and other key parameters. We anticipate that the distribution and speciation of metal contaminants in the Big and Black River Systems will be dominated by particulate material transport due to the slightly alkaline chemistry of the Missouri water systems and resultant low solubility of many metal species. The heavy metals to be the focus of this work include lead, zinc, copper, cadmium, cobalt, and nickel. Funds requested in this proposal will be used to characterize study reaches of the Big and Black Rivers (MO) and to develop and establish sampling, processing and analytical methods. These funds will also be used to characterize the bed-load and water-column metals and organics materials on a quarterly basis and also during two distinct hydraulic events: a rapid rise and fall (“summer storm event”), and a slow rise and fall (“spring melt”). One of the major goals of this study is to develop an understanding of the physical and chemical forms of transportable heavy metals within the study system and the influence that various forms may have on the transport properties of metals. Sediment samples will be sieved in the field to collect 2000 – 177 μm (coarse to medium sand), 177 – 63 μm (medium to very fine sand), and less than 63 μm fraction (silt and clay). Each fraction will be analyzed independently to determine metal contents as a function of particle size. Transport can be further influenced by the types and sizes of the various particles suspended in the water column. Water samples will be sequentially filtered to collect an unfiltered water sample, 5.0 μm filtered sample, 0.45 μm filtered sample, and a 0.02 μm filtered sample. Hydraulic monitoring will also be performed on stretches of the rivers that are being sampled for metal content. The hydraulic characterization will include USGS gauging station data where available and direct measurement of the stream hydrodynamics where USGS coverage is lacking. To this end, three gauging stations will be established on the Black River. They will be installed at stable cross sections of the river and will include upstream and downstream ends of the river reach under study. Rating of each gauging station will be accomplished by measuring discharge (velocity area method) and stage (elevation of the surface with respect to fixed datum) at various times so as to develop an appropriate rating curve (curve of discharge versus elevation). The modeling component of this project will provide an example of how a simplified model can be used to evaluate the interaction of the hydraulics, the sediment transport and the transport of metals in the rivers. Once calibrated and validated, the river model will be used to plan future data collection campaigns. The model of the Big and Black Rivers will consist of a one-dimensional application of the Environmental Fluid Dynamic Code.

Background: The Old and New Lead Belt regions of Missouri have been major producers of lead and zinc mineralization since the 1860's. These regions have historically received only scant attention with respect to contaminant migration despite their prominence as a world class lead-zinc producing regions. With respect to potential effects on contaminant migration, the lead-zinc ores of the Old and New Lead Belts differ from the typical acid mine drainage settings in the western US. These differences lie principally in the immense size of the MVT deposits (e.g., 285 million tons of ore were processed in the Old Lead Belt with the generation of 250 million tons of waste tailings), the carbonate gangue host rock, and their lower proportion of associated iron sulfide gangue minerals. Because of these differences, weathering processes in MVT waste materials generally do not result in significant sulfuric acid generation, while any acids that are generated are quickly neutralized through reactions with associated carbonate host rock. Solubilities of metals and dissolution rates of metal sulfides are expected to be relatively low under such conditions. The transport systematics of the metals under such conditions is expected to be extremely complex, being influenced in part by the effects of hydrologic sorting of mineral grains, phase solubility, abrasion, bioorganic processes, and river dynamics.

Soil Erosion and Runoff Reduction Using Three Methods of Polyacrylamide Application

Basic Information

Title:	Soil Erosion and Runoff Reduction Using Three Methods of Polyacrylamide Application
Project Number:	2002MO3B
Start Date:	3/1/2003
End Date:	2/29/2004
Funding Source:	104B
Congressional District:	Missouri 8th
Research Category:	Not Applicable
Focus Category:	Climatological Processes, Conservation, Methods
Descriptors:	
Principal Investigators:	Clark Gantzer, Stephen H Anderson

Publication

1. Mattingly, Christina A. 2004. Influence Of Raindrop Energy On Polyacrylamide Effectiveness. MS Thesis. University of Missouri-Columbia, Columbia, MO.

Because of delays in the funding, both at the Federal and campus levels, the investigators were unable to begin their projects last summer and have been granted a one- year time extension.

28 June 2004

Progress Report - Missouri Water Resources Research Center

Title: Soil Erosion and Runoff Reduction Using Three Methods of Polyacrylamide Application.

Name: C.J. Gantzer, S.H. Anderson, and A.L. Thompson

Nature, Scope and Objectives of Research:

This project is studying of the longevity of protection from application methods of Polyacrylamide Monomer (PAM) to protect soil from surface sealing and erosion. The research objective is to determine the amount of rainfall PAM-treated soil can withstand before erosion returns to untreated rates of detachment. The goal of this work is to develop improved guidelines for use of PAM to reduce soil erosion on bare soil until protective vegetative cover is established.

Progress:

A gravity-fed rainfall simulator at 6.4 cm h^{-1} was used for initial testing (Regmi and Thompson, 2000). Polyacrylamide influenced cumulative surface runoff depth and cumulative sediment loss. It was determined that applying PAM at 40 kg ha^{-1} was not significantly different than the application of 20 kg ha^{-1} PAM during a period of an hour. Separate trends were distinguished between application of 0, 20, and 40 kg ha^{-1} PAM. Measured interrill erosion rates were compared to predicted interrill erosion rates for 3 treatments of PAM at 3 rainfall rates (6.4 , 9.6 , and 12.8 cm hr^{-1}) for two fall heights (0.8 and 13.8 m). Linear regression equations were fitted to the three PAM treatments for during the 1 hr sampling time to account for the breakdown of PAM by droplet energy. A soil stabilizer factor, P , was calculated based on these regressions. The addition of a soil stabilizer factor to the modified interrill erosion prediction equation improved the percent of variation explained from 0.75 to 0.93.

Our ongoing laboratory study is using a rainfall simulator (Miller, 1987) that produces a constant intensity of 80 mm/hr with rainfall energy of $25 \text{ J m}^{-2} \text{ m}^{-1}$. Cumulative studies of 3 one-hour duration events hours (a total rainfall 240 mm) for each test bed are being done on bare soil beds of $1 \text{ by } 0.3 \text{ by } 0.3 \text{ m}$ in size on a 5% slope. Mexico silt loam soil (fine, smectitic, mesic Aeric Vertic Epiaqualf) has been collected from Bradford Research Center. Disturbed soils has been collected and air-dried, and sieved to pass a 4 mm sieve and packed into soil beds to a bulk density of $\sim 1.3 \text{ g cm}^{-3}$. Results of runoff and erosion data from these rainfall simulations will be present at the Soil and Water Conservation Society Meetings in St. Paul, MN this July.

Rainfall and runoff is being monitored throughout the tests. Treatments include four levels of solution application of PAM (20 , 40 , 60 , and 80 kg ha^{-1}) in single and split applications. Ultra high resolution x-ray CT of soil surface seals formed from raindrop impact will be used in

fall of 2004 to create 3-D volume rendered images to characterize the surface seal macropore volume, number, size-distribution, perimeter, circularity, topological dimension, and pore-connectivity, tortuosity, volume and width using the 3-D medial axis software package written by Lindquist.

Training: This project is assisting in the training of a M.S. Soil Science graduate student, Mr. Nazifi Rabiou. In addition Christina A. Mattingly An M.S. student in Biological Engineering successfully defended a thesis Influence Of Raindrop Energy On Polyacrylamide Effectiveness that is related to this grant and is the basis for the redesign of the ongoing testing. This project also has been useful for training several undergraduate students.

Publications: Mattingly, Christina A. 2004. Influence Of Raindrop Energy On Polyacrylamide Effectiveness. MS Thesis. University of Missouri-Columbia, Columbia, MO.

Information Transfer Program

8th Annual Mid-American Environmental Engineering Conference

The Missouri Water Resources Research Center hosted the 8th Annual Mid-American Environmental Engineering Conference held at the University of Missouri-Columbia campus on October 17-18, 2003. The Conference covered 15 seminars that were Graduate Student Based research on environmental and water quality with students and faculty attending and speaking at the Conference from University of Missouri-Columbia, University of Missouri-Rolla, Washington University, and Southern Illinois University Edwardsville.

MOWRRC Website

The purpose of the Missouri Water Resources Research Center website, <http://www.missouri.edu/~mowrrc>, is to inform the public of the mission and current activities of the Center. It provides information on the Call for Preproposals and the guidelines for submission as well as provides valuable links to many other sources of water information. The USGS web page has been extensively updated during the 2003-2004 year. For the first time we used the website to solicit the Call for Preproposals. The increased visibility from using the website seemed to be successful because the previous year there were nine preproposals for evaluation and this year using the website 15 preproposals were submitted.

Seminar Series

The Water Center, in cooperation with the Department of Civil and Environmental Engineering, at the University of Missouri-Columbia hosted a seminar series. The speakers and topics included:

1. Topic: Remote Sensing/Laboratory Safety Speaker: Scott Adams, Research Specialist, University of Missouri-Columbia Dr. Tom Clevenger, Director, Missouri Water Resources Research Center
2. Topic: The Ukraine Speaker: Pavlo Bohutsky, Visiting Scholar from the Ukraine
3. Topic: HAAs/THMs Variability in Missouri & Destruction of Malathion with UV Speakers: Jing Chen, Graduate Research Assistant, University of Missouri Tom Clevenger, Director, Missouri Water Resources Research Center
4. Topic: Reduction of Co (III)-EDTA Coupled with Microbially Mediated Goethite Reduction Speaker: Dr. Baolin Deng, Associate Professor, Civil Engineering, University of Missouri-Columbia
5. Topics: Arsenic removal from Drinking Water Using Clay Membranes and Determination of Arsenic Speciation by HPLC and HG-AFS Speakers: Jun Faung and Zhing Gu, graduate students, University of Missouri-Columbia
6. Topics: Microbial Controls of Electrical Properties at NAPL-Contaminated Sites: Implication for Remediation Monitoring Speaker: Gamal Z. AbdelAal, University of Missouri-Rolla
7. Topics: Development of a Granular Iron-Containing Adsorbent (AS-CAGTM) for Arsenic Removal from Drinking Water/A Pulsed Electric Field Water Treatment System Using Magnetic Pulse Compressor/Degradation of NDMA by UV Irradiation Speakers: Zhimang Gu, Graduate Research Assistant, University of Missouri-Columbia Renuka Narsetti, Graduate Research Assistant, University of Missouri-Columbia Xiaoyan Qin, Graduate Research Assistant, University of Missouri-Columbia
8. Topic: Chromium Speciation in Hanford Site Soils: A Selective Extraction and Coprecipitation Study

Speaker: Dr. Bin Hua, Civil & Environmental Engineering, University of Missouri

9. Topic: Biological Nutrient Removal through the Activated Sludge Process Speaker: Dr. Vikram Pattarkine, Director of Process Engineering, Environmental Dynamics, Inc.
10. Topic: Fouling Issues with UV Treatment Systems Speaker: Suriakannan Mathu, Graduate Research Assistant, Missouri Water Resources Research Center, University of Missouri
11. Topic: Remote Sensing for contextual Analysis, A Transport Example Speaker: Dr. Kathleen Trauth, Assistant Professor of Civil & Environmental Engineering, University of Missouri-Columbia
12. Topic: Clay Membrane Processes and Engineering Applications Speaker: Dr. Mike Whitworth, Department of Geological Engineering, University of Missouri-Rolla
13. Topic: Bioconversion of Wastewater Sludge to Value Added Products Speaker Dr. R.D. Tyagi, Professor Institut National de Recherche Scientifique IINRS-University of Quebec, CANADA

Missouri Water Center Newsletter

The Water Center newsletter is a yearly publication. The purpose of the Center's newsletter is to inform the scientific community, as well as the public, of the activities of the Center, i.e., new research projects funded, and upcoming conferences. The Center's primary focus is on its own information transfer activities and the general scope of the projects that were funded. This was also the first electronic format newsletter that was published on our website: <http://www.missouri.edu/~mowrrc>.

Student Support

Student Support					
Category	Section 104 Base Grant	Section 104 RCGP Award	NIWR-USGS Internship	Supplemental Awards	Total
Undergraduate	0	0	0	0	0
Masters	2	0	0	0	2
Ph.D.	0	0	0	0	0
Post-Doc.	0	0	0	0	0
Total	2	0	0	0	2

Notable Awards and Achievements

Project: Eutrophication in the White River watershed: Data synthesis and dynamics of planktonic communities by John Havel and Russell Rhodes.

Award: The PI was invited to present the results of htis project to the Missouri Legislators at a Meeting of the Interim Committee on Water Quality Issues (October 23, 2003).

Project: Characterization and Biological Effect Study of Endocrine Disruptors in Effluents from Missouri Sewage Treatment Plants by Yue-Wern Huang and Paul Nam.

Award: Follow-Up Grant: Endocrine Modulators and Excess Nutrients in Little Medicine Creek and Wet Locust Creek. PI: Yue-Wern Huang (65% effort); Co-Pis: Paul Nam (20%), Dev Niyogi (10%), and Roger Brown (5%). U.S. EPA Region 7 through Missouri Department of Natural Resources. \$293,266.

Publications from Prior Projects

- 2000MO3B ("Development of a Simple Combustion Process for Disposal of Waste from Livestock Operations") - Conference Proceedings - Flanigan, V.J., S. Shi, N.P. Nateri, P. Nam, K. Kittiratanpiboom and S. Kapila, 2003, A Fluidized Bed Combustor for Treatment of Farm Wastes presented at the IV International Conference on Value Added recovery and Recycling of Industrial and Agricultural Waste (Varirie 2003) L' Aquila, Italy.
- 2000MOUSDI-1434-HQ-96GR-02680-04 ("Eutrophication in the White River Watershed: Data Synthesis and Dynamics of Planktonic Communities") - Articles in Refereed Scientific Journals - Havel, J.E., and K.R. Pattinson, 2003, Spatial distribution and seasonal dynamics of plankton in a terminal multiple--series reservoir. Lake and Reservoir Management, in press.
- 2000MOUSDI-1434-HQ-96GR-02680-04 ("Eutrophication in the White River Watershed: Data Synthesis and Dynamics of Planktonic Communities") - Articles in Refereed Scientific Journals - Pattinson, K.R., J.E. Havel, and R.G. Rhodes, 2003, Invasibility of a reservoir to exotic Daphnia Lumhotzi: Experimental assessment of diet selection and life history responses to Cyanobacteria,

Freshwater Biology, 48: 233-246.

4. 2001MO3002B ("Identification and Biological Screening of Endocrine Disruptors in Effluents from Missouri Sewage Treatment Plants") - Articles in Refereed Scientific Journals - Yue-wern Huang, Jason Elrod, and Dirac Twidwell, 2003, Occurrence and effects of EDCs in the Environment. In Endocrine Disrupting Compounds in the Environment, edited by C. Adams and A. Bhandari, ASCE Hazardous, Toxic, and Radioactive Waste Management (HTRWM) Practice Periodical, 7(4): 241-252. American Society of Civil Engineering.
5. 2001MO3041B ("Spatial Distribution, Geochemistry, and Sources of Phosphorus and Metals in Bottom Sediments in the James River Arm of Table Rock Lake") - Conference Proceedings - Pavlowsky, R.T., 2003, Phosphorus pollution in the James River: Report on recent monitoring activities. SMSU Environmental Focus Forum on "Water Quality: Concerns and Realities in Southwest Missouri," April 23, Southwest Missouri State University.
6. 2002MO5B ("Microbial Influences on Geophysical Signatures: A Proxy for the Understanding and the Monitoring") - Conference Proceedings - Abdel Aal, G.Z., Atekwana, E.A., Slater L.D., 2004, Effect of different phases of diesel biodegradation on low frequency electrical properties of unconsolidated sediments, Symposium on the Application of Geophysics to Environmental and Engineering Problems (SAGEEP'04), Colorado Springs, CO, 386-395.
7. 2002MO5B ("Microbial Influences on Geophysical Signatures: A Proxy for the Understanding and the Monitoring") - Conference Proceedings - Abdel Aal, G.Z., Atekwana, E.A., Slater, L.D., and Ulrich, C. 2003, Induced Polarization (IP) measurements of soils from an aged hydrocarbon contaminated site: Symposium on the Application of Geophysics to Environmental and Engineering Problems (SAGEEP'03), San Antonio, TX, 190-201.
8. 2002MO5B ("Microbial Influences on Geophysical Signatures: A Proxy for the Understanding and the Monitoring") - Other Publications - Abdel Aal, G.Z., Atekwana, E.A., Slater, L.D., Effect of hydrocarbon biodegradation on the low-frequency electrical properties of unconsolidated sediments: AGU Fall03.
9. 2002MO1B ("Web-Based Tool for Implementing Adaptive Management in the Missouri River System") - Articles in Refereed Scientific Journals - Prato, T., 2003, Adaptive Management of Large Rivers with Special Reference to the Missouri River. Journal of the American Water Resources Association 39: 935-936.
10. 2002MO1B ("Web-Based Tool for Implementing Adaptive Management in the Missouri River System") - Articles in Refereed Scientific Journals - Prato, T., 2003, Multiple Attribute Evaluation of Ecosystem Management for the Missouri River. Ecological Economics, 45: 297-309.
11. 2002MO1B ("Web-Based Tool for Implementing Adaptive Management in the Missouri River System") - Conference Proceedings - Prato, T. Adaptive Management for the Missouri River System. 58th Annual Soil and Waste Conservation Society, Spokane, WA, July 26-30, 2003.